STANDARD METHODS FOR COLLECTING, DESCRIBING AND SAMPLING QUATERNARY SEDIMENTS AT THE ATLANTIC GEOSCIENCE CENTRE

Prepared by

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Preface

Soft sediment cores are an important data resource at most oceanographic institutions. Most cores are expensive to collect, and many (particularly those from remoter areas, or of great length) are ultimately of value to several different projects, even if originally collected for a single scientific purpose. Furthermore, cores are relatively expensive to curate.

This document outlines the principles necessary for the effective collection, description, sampling and curation of Quaternary cores; and recommends methods for carrying out these procedures. Although at times individual scientists may need to vary these procedures, all core users should ensure that their procedures do not violate the principles laid out in this document.

Any questions or suggested modifications regarding the procedures outlined in this document should be addressed to the Head, Geological Data and Curational Services, Atlantic Geoscience Centre. Copies of the document may be obtained by request from A.G.C. Data Management Section; Chief Scientists on B.I.O. ships will routinely be provided with a copy before each cruise involving Quaternary sediment sampling.

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1. STANDARD SHIPBOARD PROCEDURES

Procedures on board ship should be directed towards:

(i) minimal disturbance to the samples that are collected

(ii) accurate and standardized logging and labelling of samples

(iii) recording of all information that may be of subsequent value in interpreting a sample.

1. Piston coring

Since the piston corer does not reliably sample near-surface sediment, use a gravity corer as trigger weight for a possible surface sample. Upon extraction of trigger weight liner, keep it upright until the sediment has settled and clear water can be drained down to the sediment surface by cutting a small hole. If possible, also keep the top section of the piston core liner upright until the surface sediment has settled. Drain excess water and gas from core liner where necessary by drilling small holes and resealing. Sediment in the core cutter and catcher should be saved separately in labelled sturdy plastic bags, with orientation indicated whenever possible.

Piston cores usually should be cut into approximately 1.5 m lengths for storage. Lengths of more than 1.58 m will not fit in standard D-tubes. Longer lengths are difficult to handle and thus easily damaged. A waterproof core interval tape with cm divisions should be placed on the core liner as soon as it has been removed from the core barrel and wiped dry. The tape is double marked so the liner can later be split down the straight central line and each core half will retain a centimetre scale (Fig. 1). Note that if cores are to be used for paleomagnetism studies, a straight vertical line should be marked in permanent ink down the entire core liner,

before inserting the liners into the core barrels; the vertical marks on liners in adjacent barrels should be aligned. This vertical line will allow proper orientation of the core sections when sampling for paleomagnetism studies.

Cut and cap the liners, making sure the labelling is correct: arrow towards top, cruise and station or core number, core section number and sediment depth in centimetres on two opposite sides of liner. Write TOP and BOTTOM at the ends of the core lengths. Give trigger weight core, core cutter and catcher samples the same sample number, with the suffix TWC for gravity core, CC for core cutter and CATCHER for the core catcher. Labelling must be done with a permanent black or blue ink marker on dry surfaces or it will rub off. If different coloured core tube caps are available, use black for the bottom, red for the top. Label the red top cap with cruise and core number (it rubs off much less easily from the cap, and is easy to see if the cores are stacked). A label on a ring of masking tape is an additional precaution. If you use the procedure of numbering core sections, number from bottom to top; i.e. if there are 3 sections, bottom is 1/3, middle is 2/3 and top is 3/3.

There are several procedures which may help minimise damage to cores during coring operations:

1. By your actions and interest, make sure that the ship's crew understand your interest in a well-preserved core. Check that the scope length is correct before taking the first core.
2. Avoid the use of warped liner or pipe, which may result in liner becoming jammed.

3. The corer should be horizontal, or even tipped slightly forward when on board so that water pressure does not lead to extrusion of short core sections. The corer barrel should be broken (i.e. uncoupled from the corer head) from the top down.
4. Any core for geotechnical work must be removed from the barrel directly into a portable core rack, so that it is not flexed.
5. Always have ready some lengths of split liner, so that lengths of core that are accidentally extruded on deck can be saved. (They may be of vital stratigraphic importance, even if too disturbed for most other purposes).
6. Gassy cores are a problem, because expansion tends to blow off even well-secured caps. Try drilling small holes at ca. 25 cm intervals in the liner, to release the gas. An extra length of liner can be securely taped to either end of the core to accomodate the expanded sediment.
7. If sediment is irretrievably lost on deck, estimate what core length has been lost and allow for it in measuring and labelling core sections.
8. If cores are to be used for geotechnical analysis, the cores should be handled in racks to prevent flexing, and should be stored upright. Core ends should be dipped in hot beeswax after capping and taping to give a watertight seal. Periodic small subsamples should be taken from cut-up core ends for water content determination, so that the quality of the seal can be checked.

2. Box coring

Box core samples are taken for detailed studies of surface metre of sediment, and therefore the quality of a box core sample is important. Ideally, box cores should be full of sediment with level surface covered with clean water. Water should be removed with an aspirator or siphoned off. The ice-cube 3x3 separator should be used to provide undisturbed replicate surface samples. Box cores may then be subsampled with a core liner. For detailed subsampling at close intervals, sediments may be extruded by pushing from below and slicing consecutive layers of sediment at the top in appropriate thicknesses. Core liners must be cut, capped and labelled as for piston cores, with arrow towards top. For sampling of live foraminifera, see Section 6.3.

3. Eckman Dredge, Norwegian (IKU) and Shipek Grab

It is possible to take undisturbed samples with these samplers. Surface sediment can be recognized by its relatively high water content and light color compared to underlying material. Subsamples of surface 1-2 cm can be taken with spatulas or small core liner sections. Disturbed samples should be homogenized before subsampling. Store samples in watertight containers after labelling the dry surface with permanent ink, showing cruise and station or sample number, and type of sampler (see Table 1). For sampling of live foraminifera, see Section 6.3.

4. Van Veen Grab

Samples are normally mixed and muds should be homogenized before subsampling. Coarser sediments should include all textural sizes in the subsample. Store and label samples as for 3.

5. Rock Dredge

Every piece of rock should be kept, since the entire suite of rocks may be used to distinguish between erratics and fresh bedrock. The samples should be labelled with the cruise number and the sample number.

GSC is presently preparing a separate document describing the proper procedures for curation, storage, handling and distribution of rock dredge samples. This document will be circulated as soon as it is available. In the meanwhile, the best guideline for rock storage is to keep them under conditions as similar to their natural environment as possible, so that chemical changes are slight and there is minimum contamination by dust, etc. Usually, the wet samples should be put in a waterproof container and kept in cold storage. Soft rocks should not be cut with metal because of metal contamination and possible damage to crystal or grain structures.

2. CORE SPLITTING PROCEDURES

Cores collected in plastic liners, such as conventional gravity and piston cores, are generally split longitudinally for further study and analysis, with one half labelled and used as working half and the other half becoming an undisturbed archive half. Exceptions are core lengths for specific geotechnical or geochemical tests. Occasionally, cores may be X-radiographed prior to splitting, but little useful information is generally obtained from cores more than 4 cm in diameter, e.g. Leheigh cores (see Section 5 on X-radiography).

The following principles should be followed in splitting cores:

(i) cores are more easily damaged by transport after splitting, but are of little value for most scientific purposes before

splitting. Some scientific tests must be done on freshly-split cores. It is thus a matter of judgement when it is best to split a core. Splitting should not usually be delayed more than six months after collection.

(ii) splitting should be done with care to minimize damage to cores, and all unusual procedures should be noted.

At AGC, a router system is presently used for cutting the core liner; techniques used elsewhere include knives and saws. The tools needed for core splitting are listed in Table 2.

First make certain that the arrow pointing to the top of the core is clearly indicated on both halves and that both halves of the core liner will contain the cruise number and the sample number after splitting. Split the core along the centre of the core interval tape (Fig. 1). Cores that have been marked for paleomagnetism studies should be split so that the vertical line is in the centre of the working core half. Normally the core caps should not be removed so that sediment does not extrude. However, it may be necessary to remove the core caps in order to set the router bit at the proper cutting depth. The ideal cutting depth will leave a thin piece of liner protecting the core that can then be split by hand. Although this ideal is difficult to meet, it is important to try and leave this layer of liner to prevent plastic chips from entering the core. If the bit does cut through the liner, running the bit or a small spatula gently along the groove cut in the liner will help remove most of the plastic chips without disturbing the sediment.

Once a groove has been cut on each side of the liner, lay the core so that the grooves are perpendicular to the working surface (see A in Fig. 1). Using a rubber hammer only if necessary, pull the knife through

the remaining layer of liner. Next, turn the core so that the grooves are parallel to the working surface (see B in Fig. 1), and pull a 15 cm long piece of wire or nylon thread through the grooves the whole length of the core. Always use nylon thread or copper wire if paleomagnetic measurements are to be made. Pull the wire from bottom to top to minimise downcore microfossil contamination. This will split the sediment. If there is an obstruction (such as a rock) in the path of the wire, start again at the opposite end of the core and work up until you meet the obstruction. Finally, again lay the core perpendicular to the working surface (see C Fig. 1) and use a spatula to gently pry the two halves of the sediment core apart.

For very sticky mud cores, use of a large spatula often results in gross sediment disturbance and gouging during separation. This problem can often be avoided by following special procedures for sticky muds. (i) Run the wire/nylon through the core twice. (ii) Trickle a little distilled water down the vertically oriented furrow. (iii) Wait 5-10 minutes for the water to penetrate and lubricate the furrow. (iv) Separate the halves with a spatula, taking care not to break the surface tension (suction force) between the core surfaces and the core liner.

After the core has been split, cover both halves with thin wrapping plastic (eg. Saran wrap). Once the descriptions and subsampling have been completed, both halves of the core should be wrapped in heavy plastic tubing and sealed with masking tape before being placed in D-tubes.

3. CORE LABELLING AND STORAGE

To prevent loss and/or damage of samples, several procedures must be followed as outlined below.

1. All cores are to be permanently labelled with the following:
   (i) cruise number
   (ii) sample number
   (iii) top and bottom, and arrow pointing to top
   (iv) core interval
   (v) archive/working

   The labelling should be located lengthwise on the D-tube, on the end of the D-tube, on the plastic wrap of the core and on the core liner.
2. All cores must be wrapped in heavy plastic and saran wrap before being placed in D-tubes. Make sure both ends of the D-tube are securely fastened shut with tape. If either or both ends have not been properly fastened shut, the cores will slip out of the D-tube when taken from the shelves. Unwrapped cores dry out quickly and they shrink or crack, making them almost useless for detailed sedimentological or paleoecological studies.

4. SEDIMENT CORE DESCRIPTION

4.1 INTRODUCTION

Although cores are usually collected for a specific project, they are a common data resource at A.G.C., and over a period of years, many cores may be used by several different scientists on several different projects. This means that:

(i) a minimal basic description for each core must be available;

(ii) sampling of cores should take into account the needs of future users;

(iii) all core data of general application should be available through A.G.C. Data Section; this includes the CORE AND SAMPLE FIELD LOG (see Sect. 8) and a minimal LITHOLOGIC DESCRIPTION (Fig. 2); whenever possible, X-radiographs should be taken, and turned over to Data Section at the conclusion of the study.

(iv) color photographs (see set-up in Fig. 3) of freshly split cores are very valuable for permanently recording features of sediments that show large variations in colour down-core. The format shown in Fig. 3 can provide more information than the most careful descriptive log.

Data Section are responsible for storage and handling of both core descriptions and X-radiographs, which will be loaned to individual scientists according to normal Data Section procedures. Core photographs should also be curated by Data Section on completion of a study.

Minimal Basic Description

This procedure is required for all projects and data are generally available, as if they were on open file. The minimal requirement is to complete the LITHOLOGIC DESCRIPTION column of the Standard Core Description Form. This is intended to give an overview of the type of sediment, in a degree of detail that is relevant to subsequent more detailed studies of geochemistry, micropaleontology or sedimentology. It should consist of a

simple summary of the predominant textural and compositional features and the Munsell colour of sediment units, which are typically of the order of 50 cm thick; the minimal description also includes delimiting the tops and bases of the sediment units.

Detailed Description

This procedure may be quite specific, depending on project purposes. However, it is preferable to give a detailed description of a core following the procedures outlined below, including preparing X-radiographs (ideally made of the working core half prior to sampling) and colour photographs. This ensures that reasonably standardised information is recorded for all A.G.C. cores.

4.2 STANDARD DESCRIPTION PROCEDURE

Core log sheets (Fig. 2) consist of a header section and a data section. The header section must be filled in before starting the core description.

1. HEADER SECTION. The header box records the A.G.C. core number, depth intervals, name of person describing the core and date of core description. Fill in the header as shown in 1.1 to 1.6.

1.1 CORE. Eight spaces are provided for the A.G.C. core number, which consists of year (2 spaces), cruise number (3 spaces) and core station number (3 spaces), e.g. 82 - 004 - 022. This number is used to cross-reference to the Data Section listing of ship-board collection data.

1.2 INTERVAL. Two sets of 5 spaces, separated by a hyphen, record the core depth in centimeters at the start and end of the core section being logged; e.g. if a core 10 metres long was being described, page 1 would read 0 - 100, page 2, 100 - 200 .... page 10, 900 - 1000.

1.3 DESCRIBED BY. Enter your surname, then a comma and the initials of your first names.

1.4 G.S.C. CODE NAME. This is the 5-digit alphanumeric code used to identify projects and the project leaders.

1.5 DATE. This records the day, month and year of the core description, e.g. 16 - 05 - 82.

1.6 ALTERNATE NO. These spaces are used only if a separate identifier number has been assigned to a core for special purposes, e.g. geochemistry or other studies. Note that use of subsampling numbers on bright yellow pre-printed labels may simplify record keeping and reduce errors in labelling. The subsampling numbers are also easily entered in computer files.

2. CORE DATA SECTION. Spaces are provided at the top and bottom of the left-hand vertical axis to indicate the depth at the top and base of the section being logged. The first 6 labelled columns are for basic information which is coded as shown in 2.2 to 2.7. The columns are followed by spaces for summary descriptions of lithologic type and sediment structure, as explained in 2.8 and 2.9 below. The last column indicates the depths sampled for grain size, microfossil or chemical analysis, C-14 dating, etc. When filling in the data section, note that the depth interval is in centimetres, with zero set at the surface of the mud in the top core sec-

tion (this is often below the top of the plastic core liner). Mark this zero point with a black line on the core liner. Plastic markers may also be inserted in the sediment at 100 cm intervals downcore and the core liners should be marked at these points. The markers are useful for relocating sediment structures or microfossil sample intervals after several years of storage during which cores shorten due to dessication.

2.1 PREPARATION OF CORE SURFACE. Cores are described after splitting and smoothing the split surface by scraping it lightly at a 10° angle relative to the liner edge, using a thin-bladed spatula. Do not scrape deep; do not wash the core surface and do not use surplus sediment to fill in holes. Smoothing off irregularities on the core surface results in better visibility of fine structure and X-radiographs that are easier to interpret. In rare cases of very slow sedimentation rates (e.g. 1 mm/1000 yrs in Arctic Ocean cores), the possibility of biostratigraphic contamination by scraping across faunal boundaries must be weighed against the advantages of seeing fine structural detail. Contamination can be reduced by frequent cleaning of the spatula with paper towel.

2.2 DEFORMATION. Column 1 indicates the type and severity of visible disturbance of primary sediment structures due to coring or core-handling procedures (e.g. suck-in, tearing during core splitting) or due to in-situ geological events (e.g. folding, slumping, etc.). Select and record the most appropriate symbol from the following set:

V	Void, i.e. an empty space due to loss during coring, or to dewatering or gas expansion
	Highly disturbed - no trace of original bedding
	Disturbed - original bedding recognisable but highly distorted
	Slightly disturbed - original bedding bowed
x x x	Fractured, i.e. broken into blocks

If a more detailed description is needed, fine-scale deformation can be sketched in the LITHOLOGY and X-RAD. STRUCTURES columns.

2.3 CONSISTENCY. Column 2 records the degree of sediment compaction, using one of the following letter symbols:

SO Soupy, i.e. flows into holes as a sloppy mass

SF Soft, i.e. holes can easily be poked with your finger

ST Stiff, i.e. resists finger pressure

H Hard, i.e. hard to split into core halves or to cut with a thin-bladed spatula.

2.4 $CaCO_3$. Column 3 records qualitative estimates of carbonate content on a scale of 0 - 3 , as determined by the reaction of a mud scraping (1-2 mm^3 is enough) removed from the core and stirred with a drop of 1N Hydrochloric Acid (HCl). Choose a value from the following semi-quantitative scale:

0 No visible HCl reaction; 1 Fizzing barely visible; 2 Obvious but not violent fizzing; 3 Violent fizzing and sample almost completely dissolved in HCl.

Note that in some cores, laboratory determination of $CaCO_3$ content may also be desirable.

2.5 COLOUR. This is recorded in column 4 as a Munsell colour scale symbol. Indicate whether you are using the Soil Colour Chart (S) or Rock Colour Chart (R) by marking the appropriate box at the top of column 4. Colour is most conveniently determined by placing plastic film over the core surface, and holding the soil colour cards directly against the core. When possible, colour determinations should be made with fluorescent lighting - record in NOTES if other light is used. Colour should be determined within 30 minutes of splitting the core, because of the effects of oxidation. Colour photographs should be taken as soon as possible after splitting a core.

2.6 LITHOLOGY. Column 5 records the sediment texture (grain size), type of clasts visible at the surface (e.g. shell, clay ball), and the presence of visible casts, e.g. worm burrows. Use the standard pictorial symbols shown in Fig 4. A guide to assessing grain size is shown below - the abbreviations such as Cl and Si may be used for the LITHOLOGIC DESCRIPTION (2.8).

Cl Clay - feels very fine and sticky; will roll into a ball and is not gritty when chewed.

Si Silt and silty mud appears fine-grained but it seems to "tear" when lightly scraped, it will not roll into a ball, and it is gritty when chewed.

M Mud is a general term for sediment which is mostly fine-grained (a mixture of silt or clay) and contains less than ca. 20% sand or gravel.

Sa Sand - grain size ranges from 64 μm to 2 mm; the Sand Classification Chart may be used to specify details.

Gr Granule - size ranges from 2 mm to 4 mm in mean diameter.

Pb Pebble - size ranges from 4 mm to 6.4 cm in mean diameter.

Cb Cobble - maximum diameter is more than 6.4 cm.

2.7 X-RADIOGRAPH STRUCTURES. Column 6 records bedding structures, lithoclasts, bioclasts and other features which can be seen in the X-radiographs but were not recorded in column 2 because they are not visible at the core surface. Record the X-radiograph features using the symbols listed in 2.2 and Fig. 4.

2.8 LITHOLOGIC DESCRIPTION. This should be a simple summary statement of the predominant textural features and colour for sediment units, which are typically about 50 cm long (less in cores from water depths of over 1000 m), but unit lengths may range from c. 25 to 150 cm. The following features should always be recorded (Fig. 5):

(A) the depth interval of the unit, e.g. 2 - 28 cm, the dominant colour, e.g. OLIVE GRAY, and the dominant texture, e.g. MUD;

(B) When bedding and/or clasts are also prominant, the basic summary statement should be qualified by reference to conspicuous lesser components, e.g. MUD, with frequent thin sand beds, or MUD, with rare scattered granules and common 2 cm beds of laminated silt; and

(C) Delimit the tops and bases of the sediment units by horizontal straight lines.

A to C above constitute the minimum acceptable core description. Details of features may be added next to the depth intervals at which they occur (Fig. 5), always recording the specific depth range, e.g. 20 - 28 cm: gray sand. Writing must be small but tidy and legible, to leave room for others to record features that they may observe but which you did not notice.

2.9 SEDIMENT STRUCTURE. This section is for notes which summarise the general nature of the sedimentary structures, e.g. bioturbation; structureless; fining upwards sandy mud (e.g. Fig. 5). Notes here can draw attention to cryptic bedding structures which may indicate important properties of the depositional environment, e.g. thin clay laminae may denote a distal turbidite facies or contour current sorting, depending on the results of detailed grain size analysis. Again, the notes should record depth intervals, and be written in such a way that additions can be made.

2.10 SAMPLE RECORD. Column 9 may be used to record the intervals of samples removed for laboratory analysis, and to indicate the type of analysis, e.g. using the following symbols:

C carbon content	PM paleomagnetism sample
F foraminifera sample	W water content
G grain size sample	^{14}C radiocarbon sample
P palynology sample	^{18}O oxygen isotope sample

Alternatively, the sample records may be reported in the SUBSAMPLE LOG (i.e., Column 9 is for scientists' convenience only). Likewise, the NOTES section of the CORE DESCRIPTION SHEET may be used to define special symbols used for the core log, the place of subsample storage (e.g. C-14 samples should be frozen or dried until submitted for analysis) or for sedimentological details that cannot be fitted into columns 8 and 9. The destination of the subsamples should always be recorded in the SUBSAMPLE LOG, however, and it is not essential to repeat the information on the CORE DESCRIPTION.

5. X-RADIOGRAPHY

X-radiographs are an important adjunct to visual core description, and often reveal structures that are not visible to the naked eye. The equipment currently used at A.G.C. is a Hewlett Packard 43805N radiography unit. Kevin Robertson, Operations Manager for Environmental Marine Geology, A.G.C., is responsible for safety and maintenance. Quality X-radiographs can only be obtained if proper care is taken and the operator is aware of the exact interpretative requirements of the scientist. The scientist should consult with the operator before and during processing to assure quality.

Safety. The Hewlett Packard 43805N radiography unit is fully equipped with safety interlocks and is designed to surpass radiation safety standards. However only authorized trained personnel may operate the system. Operators must at all times wear thermoluminescent dosimeters. Others are not

permitted within the posted area while the radiography unit is on. If proper procedure is followed, the only risk of exposure is at the cabinet-core container junction or the core container end cap. Both must be covered with the lead shields as provided.

Operators should scan the instrument weekly with the survey instrument to assure integrity. The system is checked annually by Health and Welfare Canada. Female operators planning a pregnancy must avoid contact with the X-ray equipment and remain away from it during their term.

Samples

1. The best sample for radiography is a rectangular slab of approximately 3 cm thickness in a lucite sub-sampler. Slabs of from 5 to 10 cm thick may be used but normally scatter increases with thickness and detail is lost. Slab samples are usually taken from box cores.
2. Whole Leheigh cores cannot be X-rayed unsplit: exposure time are excessive (usually impossible) and internal scatter is severe.
3. Split Leheigh cores can only be radiographed with marginal results due to thickness and scatter. However, if this is the only sample available, major structural details can be identified.
4. Benthos and equivalent cores: optimum results are obtained from smooth split cores. With care, radiographs can provide fine structural detail, but always be alert for artifacts that may be caused by core spitting disturbance, "shadow" from the core cap, nails used for marking cm intervals, or by smears accidently produced during development of the X-radiograph negatives. Whole cores should only be radiographed when necessary for geotechnical and geochemical subsampling where entire sections might be removed.

Selection of instrument settings

Prior to production of radiographs, the optimum kV and time settings must be determined. The lower the kV used, the more detail can be defined, but longer exposures are needed. Exposure times of more than 90-120 seconds are not recommended. Do not exceed 130 s exposure time.

In automatic mode (ref. Sect. 3 of X-radiography manual), expose representative sections of core with test film cassette in place at various kV settings. Usually start from 80 kV and work up to 110 kV. Record or note time required to attain 100% exposure. The lowest kV to yield 100% exposure in 60-90 sec is your optimal setting.

As the exposure sensor is only measuring spot exposures, evaluate several sites from the top to bottom of a core. Select an average kV setting and exposure time for the entire core. This will keep density gradients constant and provide radiographs from which meaningful density information can be obtained.

Sample set-up

Do not obliterate a good radiograph with unnecessary detail. Set up as shown in Fig. 6.

1. Keep film and sample in immediate contact on sample tray.
2. Centre sample and film on sample tray.
3. Stabilize core with wedge on tray or in ports.
4. Use centimeter tape with lead marks (nails tend to cause shadows) and set at appropriate marks corresponding to those on the core barrel or core interval tape.
5. Always use aluminum step scale wedge for control of density changes.

6. Use serial numbers to identify - keep log for reference; permanent detail markings may be made of developed film.
7. Always pass core from left to right in chamber, starting at zero cm.
8. With standard film cassettes, only expose 20 cm per film.

Prints versus film

Accurate interpretation of radiographs can only be made with films. Printing on paper should only be done for publication. The large Hydrographic Photo Facility can produce a print of 12-16 radiographs in one exposure if required. At a considerable cost, film positives can be produced. Prints on film or paper may not routinely be provided due to cost and the inevitable errors in interpretation that can be made from such copy.

6. STANDARD SAMPLING PROCEDURES

All sampling must follow Data Section sampling policies. A summary sampling record should be kept on the original Data Section CORE DESCRIPTION sheets.

6.1 STANDARD SAMPLING PROCEDURES FOR WORKING CORES

1. Check carefully that the core interval is accurately measured, and that it corresponds to the lithologic description.
2. Never take more sample than is necessary. Normally, never take more than half the width of the working core, or half of what is left if the interval has already been sampled. If you must have a larger sample, at least leave a narrow strip, preferably 1/4th of the working core width.

3. Always use a clean spatula for each subsample, gently scrape the core surface clean before sampling and leave a thin layer of mud on the wall of core liner.
4. When systematically subsampling a core for microfossils, equal volumes should be taken whenever possible. Volumes of wet mud can be measured by placing sample in container of known volume and measuring volume of water necessary to fill container: container vol. - added water vol. = sample vol. Use 40 or 20 dram (148 or 74 ml) sample containers.

6.2 ARCHIVE CORE SAMPLING

Like a fossil reference collection, the archive core half is meant to be a permanent record that can be referred to as new discoveries are made or new analytical techniques are developed. Permission to sample archive cores must therefore be submitted in writing to AGC Data Section, giving detailed scientific justification for the request (e.g. published core data or a paper in preparation). The request will then be reviewed by an ad hoc committee of scientists. Permission for archive sampling may then be granted under the condition that

(i) a report of the results be submitted to AGC Data Section within one year of the sampling; and

(ii) any unused sample be returned to AGC, including microfossil and paleomagnetism samples.

No more than one-third the width of an intact archive core may be sampled initially; thereafter, no more than one-half of the remaining width may be sampled. This is to ensure that there will always be some sediment left as an archival reference.

6.3 SAMPLING FOR FORAMINIFERA

1. For most non-pelagic sediments, 35 ml of sediment is recommended (This is a 5 cm long sample of half of a split Benthos-style core). For pelagic sediments with slow sedimentation rates, shorter (1-2 cm long) sample intervals are usually required.
2. Formalin solution for preservation of surface (living) foraminifera is prepared as follows:
   (i) 20 ml formalin (40%); 2 packages (7.6 g) buffer salts, 9.18 pH; 2 g calcium chloride
   (ii) Mix in 1 litre of filtered seawater shortly before using. Add preservative to equal volume of sample (in 20 or 40 dram vials) and homogenize by shaking.
3. Add Calgon and buffer solution to sample, soak and disperse sediment by shaking. Sieve only dispersed clays. Persistant clay pellets can be broken on sieve with a small brush, or with fingers or spatula pressed against the sieve frame.
4. Use 230 mesh (0.063 mm) sieve, washing the sediment with a gentle stream of tap water. Samples for isotopic analysis, or with very low foram numbers, are washed with distilled water with a gentle stream (e.g., from a squirt bottle) to prevent contamination. Wash residue on filter paper and dry.
5. For staining of preserved surface sediments for determining living specimens, treat the washed sample with Sudan Black stain (10 gm stain in 1 litre alcohol) at 40°C for 30 min. After heating, wash the sediment through 230 mesh sieve with denatured alcohol to remove excess stain, wash onto a filter paper and dry.

6. To separate foraminiferal tests from excessive amounts of sediment, the sample is floated in heavy liquid (10:4 mixture by volume of bromoform and acetone). Carbon tetrachloride can be used instead of bromoform but it represents a greater health hazard. Almost all foram tests will float and almost all sand grains will sink in this mixture of liquids. To make the separation, dry sample is slowly poured into a beaker containing the heavy liquid. After a few minutes of settling, the floating fraction can be concentrated in the central area of the heavy liquid surface by gently rotating the beaker so as to cause the liquid surface to tilt towards the center of the container.

   The foraminiferal concentrate is then easily decanted onto a filter paper and thoroughly rinsed with pure acetone to remove the bromoform. The filter paper is folded and dried. Label filter paper (with pencil, not pen) before using. Decant the heavy liquid from the "sink" fraction in a container for future use. Dry "sink" and "float" fractions should remain in a fume hood until all smell of bromoform or CCl_4 is lost.

7. Splitting

   The number of foram. tests in a sample is usually estimated from a dry sample on a counting tray, and if the total number is over 300 specimens, the sample is split with an Otto microsplitter. Continue splitting only until manageable number (300) of tests is reached in the smallest fraction. The smallest fraction is picked clean and the final split fraction is recorded (this may be 1/2, 1/4, 1/8, 1/16, etc.). If the sample is to be counted wet, a volumetric wet splitter should be used to subdivide the sample evenly.

8. Picking

Specimens are picked with a moist 000 brush and glued* in rows on 18 or 28 ply hollow cardboard slides designed for microfossils. Use gum tragacanth which dissolves in water, allowing later reorientation of specimen. A thin coating of gum tragacanth is applied to a slide before placing specimens on it. *(Note that glued specimens cannot be used for ^{18}O studies or ^{14}C micromass dating; picked specimens for ^{18}O or ^{14}C studies must be stored loose in microfossil slide trays or small glass vials).

9. Foraminiferal Index Collection

For each area or group of samples, a slide or set of slides is prepared with mounted specimens representing all of the species present. This slide is given a number and the specimens are listed individually in the UNPUBLISHED SPECIES FILE for the collection. The slide is identified by area, cruise number(s), scientist, year, etc. in the UNPUBLISHED section. The slide is placed in the scientist's collection in its appropriate location in order of the assigned number.

When data on a collection of samples are published, with the foraminiferal data specifically used, the specimens are then transferred from the multiple-species slides to individual slides in the EMG PUBLISHED COLLECTION. The species name is assigned a GSC collection number if it has been illustrated; the publication location, scientist and collection number are recorded on the slide. The slide is listed under the scientist as a publication with date, location and the numbers assigned for those specimens. Each species is also listed separately with a reference to the slide number and the publication.

In many cases, illustrated specimens are either on SEM blocks, or transferred to the GSC collections in Ottawa. In such cases, duplicate index specimens are mounted and labelled as such to provide us with as complete a selection of material as possible.

Various slides have been given to us by other scientists. These are simply numbered and placed in a SPECIAL COLLECTION, which is cross referenced with the donor's name, any data pertaining to the slides, and the individual species. These are kept separate since they are not published by scientists here, and, in many cases, they are unpublished data.

Almost all of the AGC Recent and Quaternary foraminiferal collections are curated by F. Cole and B. Deonarine, EMG. A few samples are curated by F. Thomas, EPG.

6.4 SAMPLING FOR RADIOCARBON DATING AND PALYNOLOGY

Philosophy

It is necessary to have a reasonably good idea about the stratigraphic setting of the sample: an isolated C^{14} date without any stratigraphic connotation is useless. Useful ages may be obtained from a raised deposit that is part of a system of raised marine deposits. In sediment cores a C^{14} date may be useful to establish the age of a lithostratigraphic or acoustic unit of regional importance. A distinct micropaleontological zone/horizon could be dated with a single C^{14} age. Two or more C^{14} ages per core are needed to calculate average sedimentation rates or to establish the mode of sedimentation in otherwise featureless sediments. Whenever possible, request that $\delta^{13}C$ measurements be provided with the C-14 dates because the $\delta^{13}C$ data can often be used to evaluate the reliability

of the radiocarbon dates.

Contamination

Organic matter preserved in muds can be of a large range of ages due to multiple sources. Of primary concern is the ratio of locally derived organic matter to reworked mid-Wisconsinan or older kerogens, e.g., hard coal and dark brown amorphous debris, which constitute "dead" carbon. Before deciding on C^{14} analysis of Total Organic Carbon (TOC), small subsamples (5 cm^3) should be examined for the presence of refractory organic material (inertinite, lignite, pre-Quaternary pollen). For palynology, samples should be processed according to the method of Barss and Williams (1973). Acetolysis treatment should not be used, so that the extracted organic material can be examined by fluorescence microscopy, which is useful for detecting the presence of Tertiary or older amorphous debris in the fine sediment fraction.

Samples containing organic carbon less than 3% are unlikely to produce reliable dates from TOC, especially if they are older than about 7,000 yrs and show low background fluorescence or a high ratio of pre-Quaternary to Quaternary palynomorphs. Samples with these characteristics almost invariably give ages of c. 20,000 to 28,000 yrs. B.P. For a marine sediment deposit, marine versus terrestrial organic carbon should be high as indicated by C/N ratios of less than 7.0 or δC^{13} values of -21 to $-24°/_{oo}$. For uncontaminated wood or peat, $\delta^{13}C$ values more negative than $-25°/_{oo}$ should be found.

Molluscan shells may give spurious C^{14} results due to recrystallization of shell material (aragonite→calcite) or inorganic calcareous deposits. Shells therefore should be fresh, without obvious evidence of

transport or diagenetic features and preferably with intact hinges and periostracum linings on bivalves. Note, however, that modern shells may bury into older exposed sediment, e.g. surface till deposits; this will give a much younger than true age for the sediment. Conversely, a Tertiary shell may give an age of c. 40-50 Ka if the contaminated outer layer is not completed removed by acid treatment. Shell dates are most useful if the species is identified before sending the sample for ^{14}C analysis because identification may confirm of the in-situ position of the shell.

Sample Size

TOC: GSC laboratory needs at least 400 g of wet sediment containing organic carbon not less than 1% (about 17 to 20 cm length of a split piston core). Smaller samples may be used if they have a higher C content, but allow for recovery of at least 1 g of C from the dry sample. Note that TOC dates of nearshore sediments are more likely to be accurate if they contain more than 3% TOC and a large amount of coarse wood or other plant fragments.

Shell material: At least 4-5 g of well preserved shell is required from marine cores, although good dates have been obtained from well preserved shells weighing 3.15 g. Larger amounts (10-13 g) of shell are needed if the outer shell layer has been contaminated by leaching in a raised marine deposit.

Peat and Wood: These are usually excellent dating materials but about 25 - 50 grams of clean, dry material is desirable for an accurate pre-Holocene age. It is also very important to determine that the peat or wood is in situ if it is to be used for dating a litho- or biostratigraphic unit. In marine environments, there should be evidence that the peat bed

has considerable lateral continuity. It is also important to determine the ^{13}C value of the peat so that correction can be made for plants with C_4 or CAM photosynthetic pathways.

Review and Approval Procedures

To ensure standardization of all carbon dating and analytical results, all AGC staff are required to prepare sample submission forms per sample after approval of their Subdivision Head (Fig. 7). A committee will review each request for sample quality, requested procedures and to verify that all pertinent data is recorded.

6.5 SAMPLING FOR SEDIMENT ANALYSIS

Sampling for subsequent grain size analysis, or lithologic determination such as carbonate content or clay mineral analysis, require careful definition of the scientific problem and careful sample selection to meet these objectives. In lithologically heterogenous cores, sampling should be done in conjunction with study of carefully aligned X-radiographs. Samples should not normally cross lithologic boundaries. Many lithologic properties vary substantially with grain size, so that a grain size analysis should be made of the same core interval as the lithologic analysis, when sample size permits.

Appropriate sample sizes are:

Coulter Counter only - 0.5 g

Sedigraph - 1.5 g minimum, but larger samples much easier to handle

Settling tube and Coulter Counter or Sedigraph - equivalent of 3-4 g coarse sand, or 1-2 g fine sand

X-ray diffraction - 10 g

Heavy mineralogy - equivalent of 10 g sand

Organic carbon - at least 5 g wet sample*

Carbonate - at least 2 g wet sample

*For special studies, e.g. of thin laminae, smaller samples may be analysed but the problem should first be discussed with W. LeBlanc, Environmental Marine Geology Subdivision, A.G.C.

7. DATA STORAGE

Data Section are responsible for storage and handling of core descriptions, X-radiographs, core and sample field logs, subsample logs and core splitting logs. These records will be loaned to individual scientists according to normal Data Section procedures.

8. STANDARD FORMS TO BE COMPLETED AND FILED IN AGC DATA SECTION

CORE AND SAMPLE FIELD LOG

I Collection

Project No.
or Cruise No. ☐☐-☐☐☐

Latitude ☐☐☐☐☐☐☐ check for sec.

Deg min.

Longitude ☐☐☐☐☐☐☐ check for sec.

D M Y Julian Day Time Zone

☐☐☐☐☐☐ ☐☐☐ ☐☐☐ ☐☐☐ ☐☐☐ ☐☐☐

Depth ☐☐☐☐☐ ☐☐ Over Side meters ☐ On Bottom fathoms ☐ At Surface ☐ feet ☐ sec.

No sample collected ☐

Station No. ☐☐☐ Sample Type _____

Sample Description Notes:

Sample Recovery Routine ☐ Damage ☐

Subsample Notes:

(A) Bottom Gram Sample No. ☐☐☐☐☐-☐☐☐

Van Veen ☐ Shipek ☐ Other ☐

No. of attempts ☐☐☐☐ Jaws open ☐ closed ☐

Munsell color code ☐☐☐☐☐

Photographed Yes ☐ No ☐

No. of Subsamples ☐☐☐

(B) Core Sample No. ☐☐☐☐☐-☐☐☐

Apparent penetration ☐☐☐☐ (cm.)

Length ☐☐☐☐ (cm.)

Piston ☐ Gravity ☐ Other _____

Final No. of Sections ☐☐ No. of Subsamples ☐☐☐

Storage vertical ☐ horizontal ☐

Shipment vertical ☐ horizontal ☐

(c) Damage Report - Yes ☐ No ☐

NOTES:

II Field Analysis

Core splitting - Yes ☐ No ☐ Splitter _____

Date _____

Core description - Yes ☐ No ☐ Describer _____

Date _____

X-radiographed Yes ☐ No ☐

Photographed Yes ☐ No ☐

Other Notes:

LABORATORY CORE SPLITTING LOG

CORE NO. _____ OK ☐

LABELS Poor ☐

NAME OF SPLITTER _____

NAME OF CORE LOGGER _____

DATE _____

NOTES ON EQUIPMENT USED, PROBLEMS ETC.

_____

_____

_____

SUBSAMPLE LOG

Date: _____ Scientist/Technician Name: _____

Core or Sample No. _____

Purpose of Subsampling: _____

Notes: _____

Subsampling Intervals: _____

Figure Captions

Figure 1. Procedure for splitting core.

Figure 2. Standard core description sheet.

Figure 3. Colour photography layout.

Figure 4. Key to symbols for standard core description sheet.

Figure 5. Example of a completed core description sheet.

Figure 6. Sample set-up for X-radiography.

Figure 7. Radiocarbon Sample Data Sheet.

FIG. 1

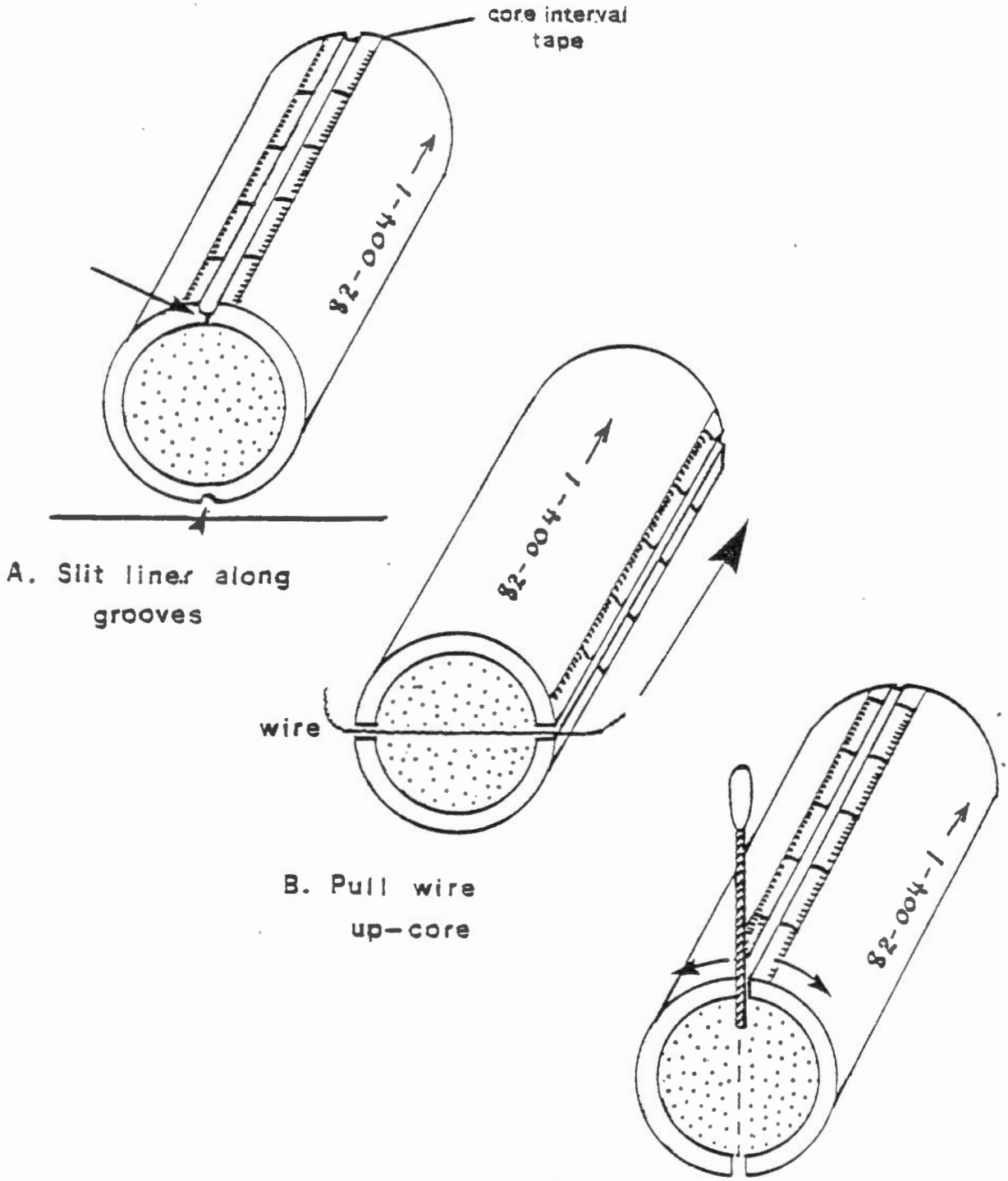

core interval tape
82-004-1
A. Slit liner along grooves
82-004-1
wire
B. Pull wire up-core
82-004-1
C. Pry apart with spatula

Table 1. Abbreviations for recording sample information

DLF	Dietz - Lafond grab
ECK	Eckman dredge
IKU	IKU grab
SHK	Shipek grab
VVG	Van Veen grab

Table 2. Core splitting tools

1. Markers (Black/Blue)
2. Router bits (3/8" and 1/4")
3. Knife with hooked blade
4. Hammer with rubber head
5. Wire or heavy nylon fishing line
6. Wire cutters
7. Spatulas various sizes
8. Plastic wrap and/or saran wrap
9. Masking tape
10. Tape measure/metre stick
11. Core interval tape
12. Squirt Bottle for distilled water

Fig. 2

CORE _____

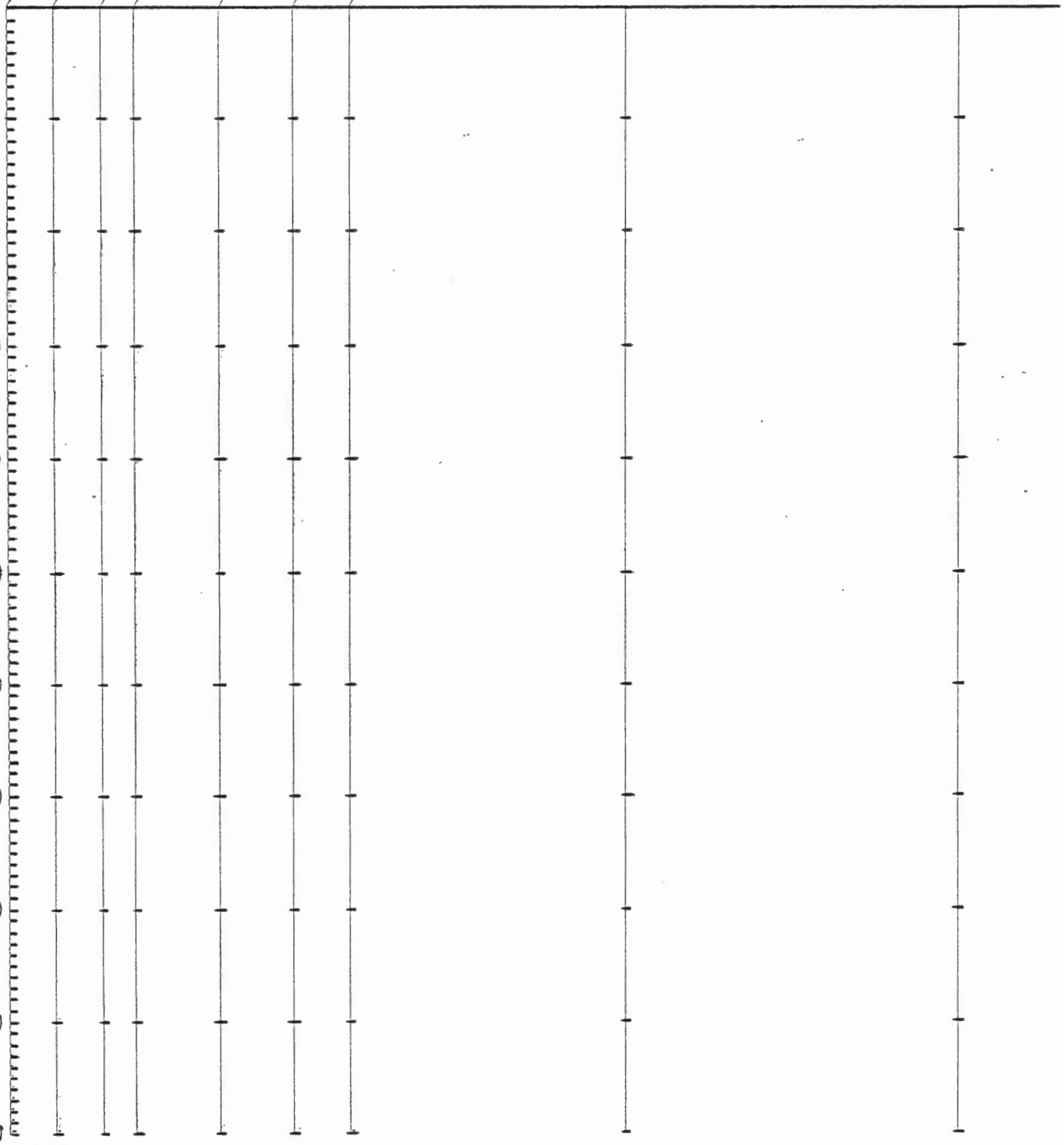
DEPTH INTERVAL _____ CM

DESCRIBED BY _____

GSC _____

DATE _____

ALTERNATE No. _____



NOTES:

Fig.3

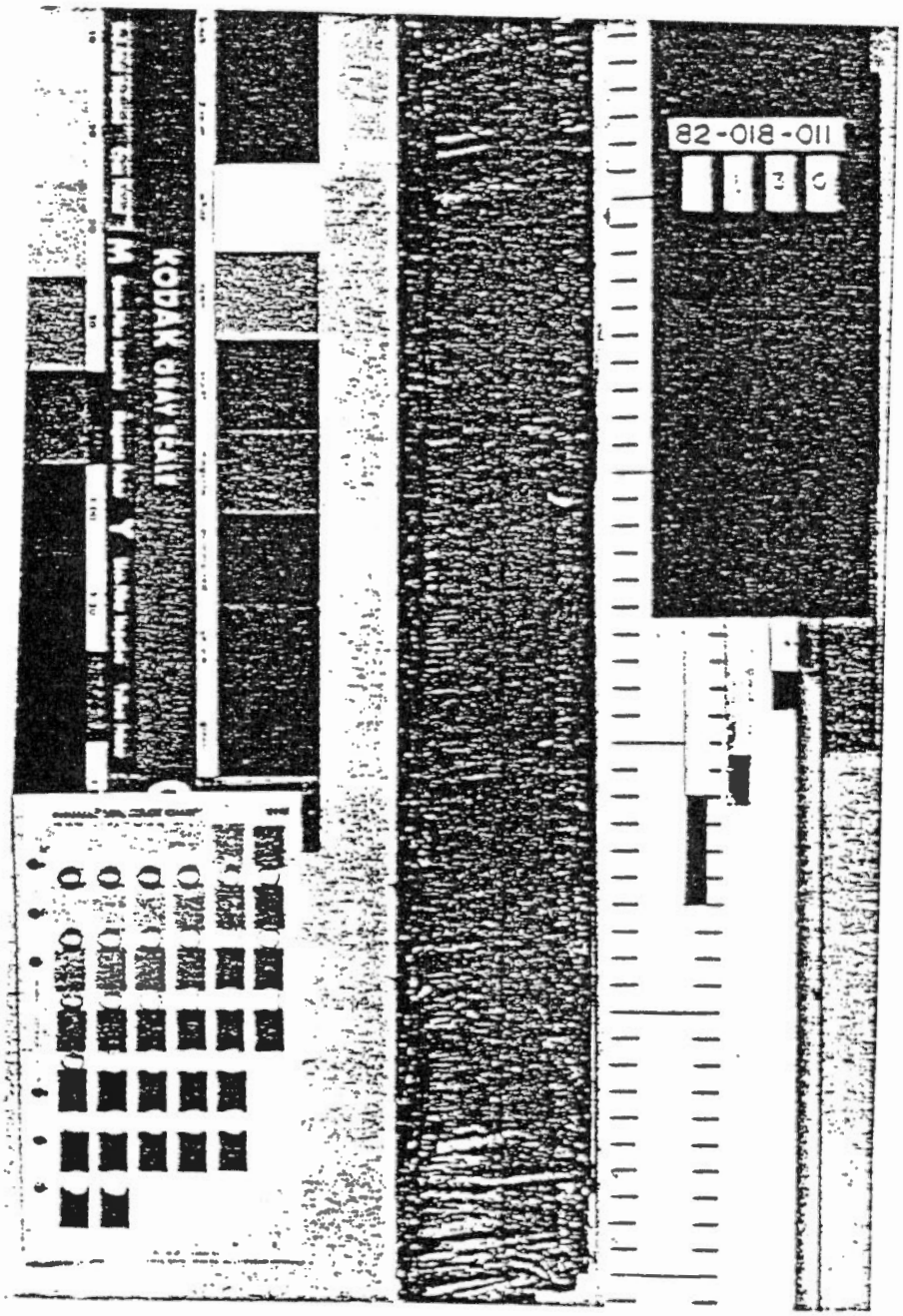
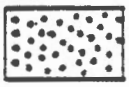
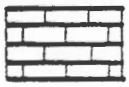
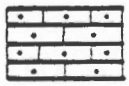
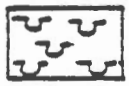
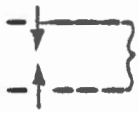


Fig.4

KEY TO CORE DESCRIPTION SYMBOLS

COMPUTER CODE	SYMBOLS	LITHOLOGY
0		MUD
1		CLAY
2		SILT
3		SAND
4		SANDY MUD
5		SANDY GRAVELLY MUD
6		GRAVEL AND ROCK
7		FORAMINIFERAL/NANNOFOSSIL OOZE
8		MUDDY CALCAREOUS OOZE
9		DIATOM OOZE

CLASTS & STRUCTUR	
	SHELL
	SEDIMENTARY CLASTS
	SEDIMENTARY CASTS
	PEAT / WOOD
	MOTTLING
	BIOTURBATION/BURROWS
Mn	MANGANESE
A	VOLCANIC ASH
	LAMINA
	GRADATIONAL CONTACTS
	SHARP CONTACT
 150	CORE SECTION BREAK

BEDDING STRUCTURE

BEDDING DISTORTED BUT STILL CLEARLY VISIBLE

LAMINAE DISCONTINUOUS

LAMINAE CURVED, DISCONTINUOUS (*BROKEN LINE*) OR CONTINUOUS (*SOLID LINE*)

LAMINAE/STRUCTURES ALL VERTICALLY ORIENTED (*INDICATES SUCK-IN*)

Fig.5

CORE 76-021-015
DEPTH INTERVAL 0-100 CM
DESCRIBED BY STONE DAVY
GSC DAM
DATE 16-09-76
ALTERNATE No.

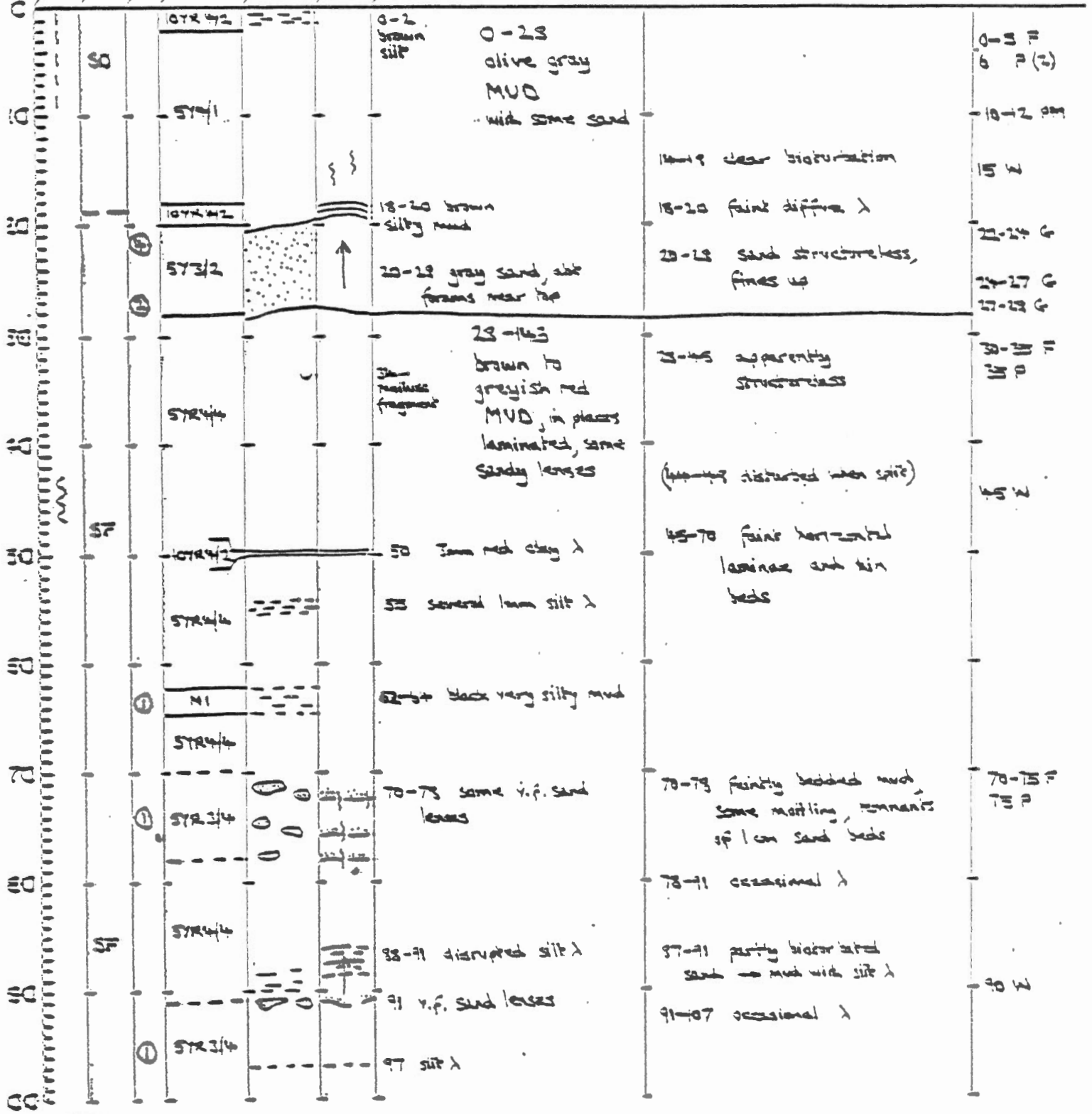


FIG. 6

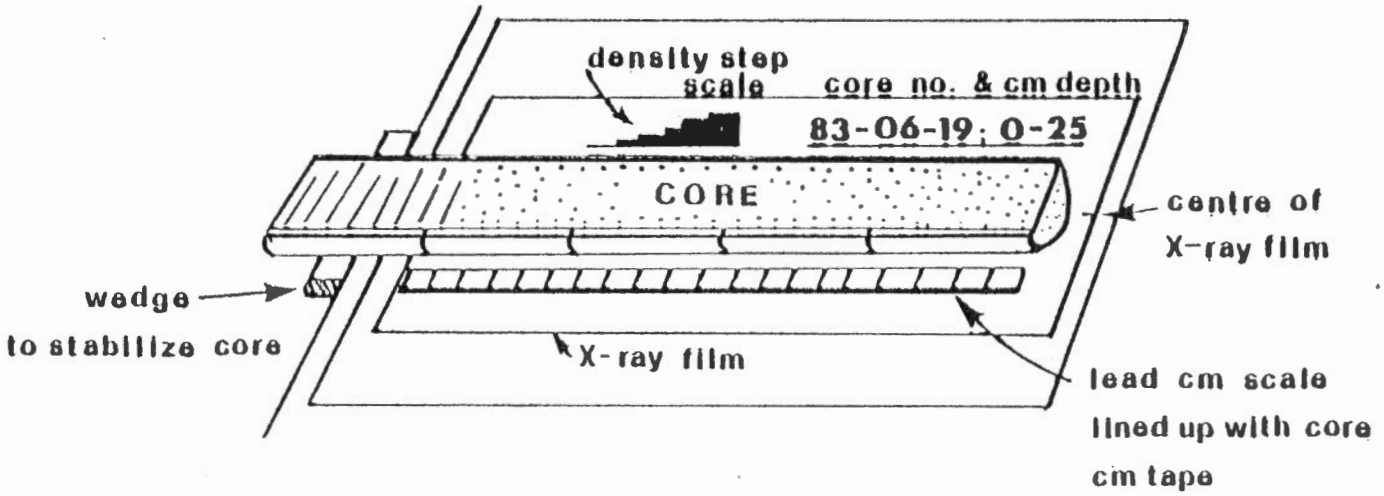

density step scale
core no. & cm depth
83-06-19; 0-25
CORE
centre of X-ray film
wedge to stabilize core
X-ray film
lead cm scale lined up with core cm tape

Fig.7 RADIOCARBON SAMPLE DATA SHEET

Please assist us by answering all pertinent questions.
It is important for best results.
All samples must have approval of C^{14} Committee prior to shipping.

SUBMITTER: Mr. Kevin Robertson (902) 426-7730 DATE: _____

ADDRESS: Energy, Mines & Resources (AGC), P.O. Box 1006, Dartmouth, N.S. B2Y 4A2

COLLECTOR: _____ (902)426- DATE: _____

AFFILIATION: Energy, Mines & Resources, Geological Survey of Canada, Atlantic Geoscience Centre, Bedford Institute of Oceanography, Dartmouth, Nova Scotia

COLLECTOR'S SAMPLE CODE NO. _____

INSTRUCTIONS TO LABORATORY
CHECK APPROPRIATE ITEMS NORMAL DELIVERY __ RUSH __

ANALYZE: RADIOCARBON __ $^{13}C/^{12}C$ __ $^{18}O/^{16}O$ __ CALCITE/ARAGONITE X-RAY __
THERMOLUMINESCENSE __

SPECIAL HANDLING: PRETREATMENT __ COUNTING __ CALCULATIONS __ OTHER __

SPECIFY _____

GEOGRAPHIC LOCATION _____

LATITUDE _____ LONGITUDE _____

TYPE OF MATERIAL _____

WEIGHT _____ ESTIMATED AGE 15,000 __ 15,000 __

EVIDENCE OF CONTAMINATION (ROOT PENETRATION, LEACHING, HUMUS, ETC)

_____

COLLECTION, TREATMENT AND STORAGE PROCEDURES _____

_____

STRATIGRAPHIC AND ENVIRONMENTAL DETAILS. PUT DRAWINGS AND ADDITIONAL TEXT ON BACK

_____

_____

_____

_____

FOR ADDITIONAL INFORMATION FROM FRONT PAGE

FOR BETA USE ONLY

BETA NUMBER	_____	INSPECTION	_____
		CARBON %	_____
RECEIVED	_____	PRETREATMENT	_____
ACKNOWLEDGED	_____	TREATMENT	_____
PRIORITY	_____	COUNTERS	_____
ESTABLISHED BY	_____	CALCULATED BY	_____
SCHEDULED FOR PROC	_____	CHECKED BY	_____
RESULT PHONED	_____	SAMPLE LEFT	_____
RESULT MAILED	_____	SAMPLE RETURNED	_____
REPORTED AGE ± 1	_____	PUBLISHED R.C.	_____

RESULTS OF: $^{13}C/^{12}C$ _____, $^{18}O/^{16}O$ _____, X-RAY _____